

DESCRIPTION OF IMMATURE STAGES OF *TRUPANEA CONJUNCTA*  
(ADAMS) (DIPTERA: TEPHRITIDAE)

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*Abstract.*—The pre-imaginal stages of *Trupanea conjuncta* (Adams) are described. *Trupanea conjuncta* is a narrowly oligophagous, univoltine, nonfrugivorous tephritid in southern California. The third instar larva differs from previously studied Tephritidae, including six congeneric species, in that the integument is finely punctate posterior of the prothorax and the median oral lobe bears lateral projections. The metathoracic lateral spiracular complex consists of a single spiracle unaccompanied by any sensilla; the abdominal lateral spiracular complex consists of a spiracle and two verruciform sensilla. Thus, the lateral spiracular complex is the only morphological feature observed to differ among third instars of all seven species of *Trupanea* studied to date. The first and second instars of *T. conjuncta* differ from the third instar in that the integument is smooth, without punctuation.

*Key Words:* Insecta, *Trupanea*, Asteraceae, nonfrugivorous Tephritidae, taxonomy of immature stages, egg, larva, puparium

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The life history of *Trupanea conjuncta* (Adams) (Diptera: Tephritidae) was described by Goeden (1987) before adoption of our current format incorporating descriptions of the immature stages. To correct this deficiency and allow full comparison of the 31 species of southern California nonfrugivorous fruit flies for which both life histories and descriptions of the immature stages now have been published, this paper describes the immature stages of *T. conjuncta*.

#### MATERIALS AND METHODS

One-liter samples of excised, immature and mature flower heads from the known hosts of *T. conjuncta*, *Trixis californica* Kellogg and *Perezia microcephala* (de Candolle) Gray (Asteraceae), potentially containing eggs, larvae, and puparia were transported in cold-chests in an air-condi-

tioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Twenty-two eggs, 23 first-, 14 second-, and nine third-instar larvae, and nine puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24h, dehydrated through an increasing series of acidulated EtOH and two, 1-h immersions in Hexamethyldisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

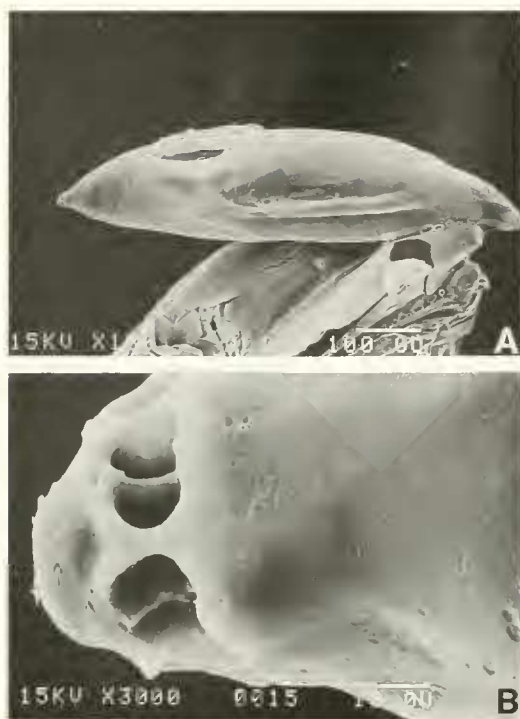


Fig. 1. Egg of *Trupanea conjuncta*: (A) habitus, pedicel to left; (B) egg pedicel.

Plant names used in this paper follow Munz (1974), as updated by Hickman (1993) and Bremer (1994); tephritid names follow Foote et al. (1993). Terminology and telegraphic format used to describe the immature stages follow Knio et al. (1996), Goeden and Teerink (1997a, b, 1998; Goeden et al. 1998), and our earlier works cited therein. Means  $\pm$  SE are used throughout this paper. Voucher specimens of *T. conjuncta* eggs, larvae and puparia are stored in a collection of immature Tephritidae maintained by JAT.

## RESULTS

**Immature stages.**—The eggs and puparium of *T. conjuncta* were described and photographs of these stages and larvae provided by Goeden (1987), but detailed descriptions, especially of larvae based on scanning electron microscopy heretofore have not been published.

**Egg:** The egg (Fig. 1A) of *T. conjuncta*

has a short pedicel with a single row of aeropyles (Fig. 1B).

**Third instar larva:** White, barrel-shaped, tapering anteriorly, rounded posteriorly; minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 2A); segments TII-AVIII finely punctate (Fig. 2A, E); gnathocephalon smooth, conical (Fig. 2B), rugose pads dorsal and lateral to mouth lumen (Fig. 2B-1); dorsal sensory organ a single dome-shaped papilla (Fig. 2B-2, C-1); subdorsal sensilla laterad of dorsal sensory organ (Fig. 2B-3); anterior sensory lobe (Fig. 2B-4) bears terminal sensory organ (Fig. 2C-2), pit sensory organ (Fig. 2C-3), lateral sensory organ (Fig. 2C-4), and supralateral sensory organ (Fig. 2C-5); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 2C-6); mouth hooks tridentate (Fig. 2D-1); median oral lobe tapered anteriorly with lateral projection (Fig. 2D-2); labial lobe and median oral lobe attached, two pore sensilla in lateral lobe (Fig. 2D-3); six pit sensilla circumscribe gnathocephalon posterior to rugose pads; prothorax circumscribed anteriorly by minute acanthae (Fig. 2E-1), rugose pads (Fig. 2E-2) and two rows of verruciform sensilla (Fig. 2E-3); anterior thoracic spiracles on posterior margin of prothorax bear five ovoid papillae (Fig. 2E-4); metathoracic lateral spiracular complex consists of an open spiracle; abdominal lateral spiracular complex consists of a spiracle (Fig. 2F-1), and two verruciform sensilla (Fig. 2F-2); caudal segment circumscribed by minute acanthae (Fig. 2G-1), and stelex sensilla in a 2- dorsal, 4- ventral arrangement (Fig. 2G-2); posterior spiracular plate bears three ovoid rimae, ca. 0.04 mm in length (Fig. 2G-3), and four interspiracular processes each with 6-8 branches, longest measuring 0.015 mm (Fig. 2G-4); intermediate sensory complex ventrad of posterior spiracular plates consists of a medusoid sensillum (Fig. 2H-1), and a stelex sensillum (Fig. 2H-2).

**Second instar larva:** White, elongate-cylindrical, tapering slightly anteriorly, round-

ed posteriorly; minute acanthae circumscribe meso-, metathoracic and abdominal intersegmental lines (Fig. 3A); gnathocephalon conical (Fig. 3B), rugose pads dorsal and lateral to mouth lumen (Fig. 3B-1); dorsal sensory organ a single dome-shaped papilla (Fig. 3B-2, C-1); subdorsal sensillum laterad of dorsal sensory organ (Fig. 3C-2); anterior sensory organ bears all four sensory organs 3C-3); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 3B-3, C-4); mouth hooks bidentate (Fig. 3B-4); median oral lobe tapered anteriorly; prothorax with minute acanthae ventrally; anterior thoracic spiracle consists of 5 papillae (Fig. 3D); lateral spiracular complex not seen; caudal segment circumscribed by minute acanthae and stelex sensilla; posterior spiracular plate bears three ovoid rimae, 0.017 mm in length (Fig. 3E-1), and four interspiracular processes, each with 3-5 branches, longest measuring 0.012 mm (Fig. 3E-2), intermediate sensory complex consists of a medusoid sensillum (Fig. 3F-1) and stelex sensillum (Fig. 3F-2).

*First instar larva:* White, elongate-cylindrical, rounded anteriorly and posteriorly, minute acanthae circumscribe intersegmental lines (Fig. 4A); gnathocephalon smooth, lacking rugose pads (Fig. 4B); dorsal sensory organ a single dome-shaped papilla (Fig. 4B-1); anterior sensory lobe bears all four sensory organs (Fig. 4B-2); stomal sense organs indistinct; mouth hooks bidentate (Fig. 4B-3); median oral lobe laterally flattened; minute acanthae on ventral margin of prothorax (Fig. 4B-4); anterior thoracic spiracle not present; abdominal lateral spiracular complex consists of a spiracle and two verruciform sensilla; caudal segment circumscribed by stelex sensilla (Fig. 4C-1); posterior spiracular plate bears two ovoid rimae, ca. 0.006 mm in length (Fig. 4C-2), and four interspiracular processes, longest measuring 0.006 mm (Fig. 4C-3); intermediate sensory complex consists of a medusoid sensillum (Fig. 4C-4), and a stelex sensillum (Fig. 4C-5).

*Puparium:* Minute acanthae circum-

scribe intersegmental lines, integument finely punctate (Fig. 5A), anterior end bears the invagination scar (Fig. 5B-1) and anterior thoracic spiracle (Fig. 5B-2); caudal segment circumscribed by minute acanthae; posterior spiracular plate bears three ovoid rimae (Fig. 5C-1), and four interspiracular processes (Fig. 5C-2); intermediate sensory complex ventrad of posterior spiracular plates (Fig. 5C-3).

#### DISCUSSION

The egg (Fig. 1A) of *T. conjuncta* has an elongate-ellipsoidal shape and short pedicel with a single row of aeropyles (Fig. 1B) like all other congeners studied (Goeden 1987, 1988; Headrick and Goeden 1991; Goeden and Teerink 1997b, 1998; Goeden et al. 1998), except for *T. bisetosa* (Coquillett), which has two rows of aeropyles (Knio et al. 1996).

The third instar of *Trupanea conjuncta* is unique among *Trupanea* species previously studied in that the integument is finely punctate in the segments posterior of the prothorax 2A, E, F) (Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997b, 1998; Goeden et al. 1998). Several Tephritid species are shagreened, with evenly distributed, smooth dome-shaped verrucae covering the integument, for example, *Tomoplagia cressoni* Aczél, *Valentibulla californica* (Coquillett) and *Xenochaeta dichromata* Snow (Goeden and Headrick 1991, Goeden et al. 1995, Goeden and Teerink 1997a); however, a punctate integument was not seen in any tephritid previously studied by us (Headrick and Goeden 1990, 1991; Goeden et al. 1995, 1998; Goeden and Teerink 1997a, b, 1998; Headrick et al. 1997; Knio et al. 1996, and our earlier works cited therein).

The median oral lobe, by bearing a pair of lateral projections (Fig. 2D-2), also differs any tephritid previously studied by us (Headrick and Goeden 1990, 1991; Goeden et al. 1995 1998; Goeden and Teerink 1997a, b, 1998; Headrick et al. 1997; Knio et al. 1996, and our earlier works cited



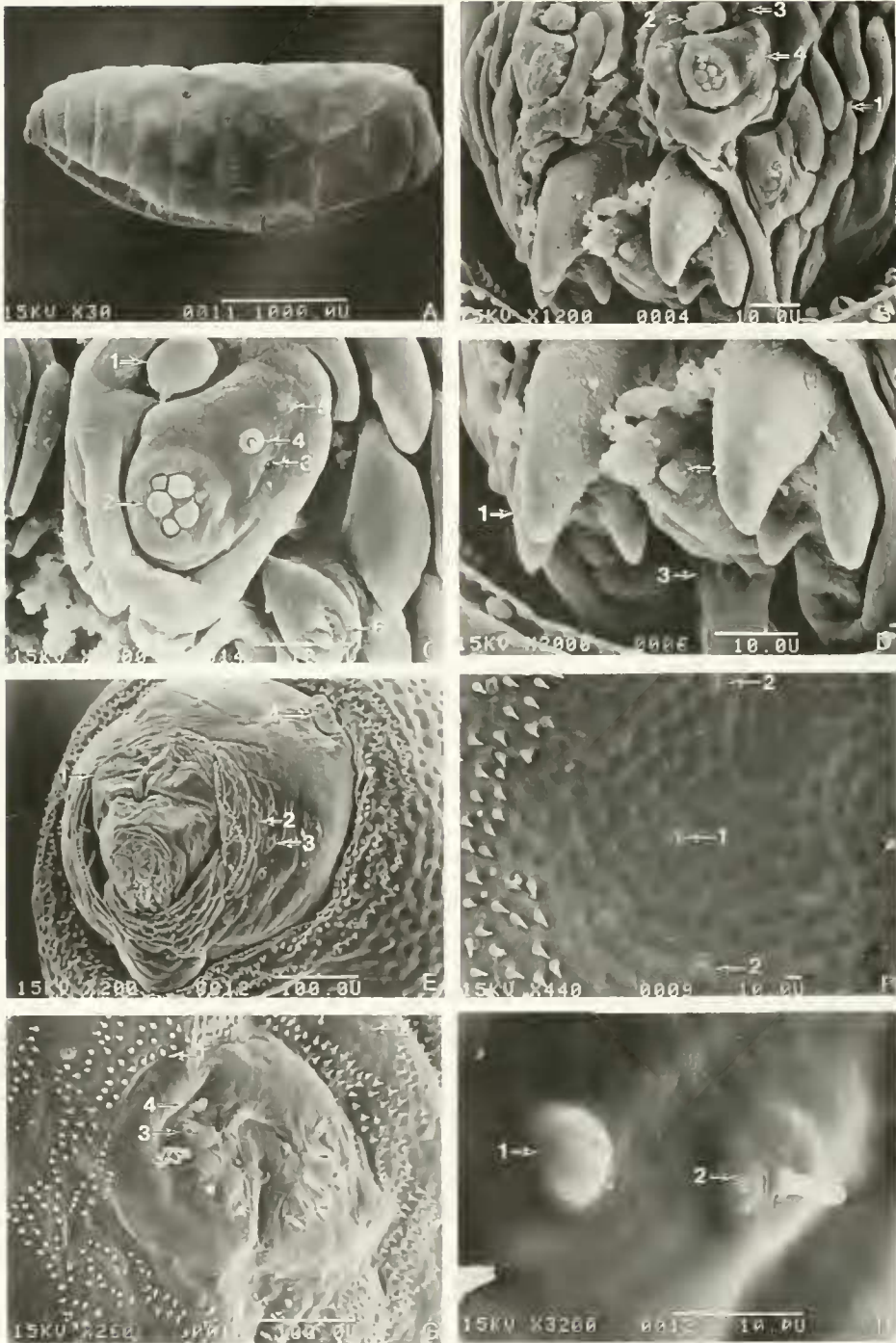


Fig. 2. Third instar of *Trupanea conjuncta*: (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal sensory organ, 3—subdorsal sensilla, 4—anterior sensory lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ, 6—stomal sense organ; (D) gnathocephalon, ventral view, 1—mouth hooks, 2—median oral lobe, 3—labial lobe sensilla; (E) gnathocephalon, prothorax, mesothorax, lateral view,

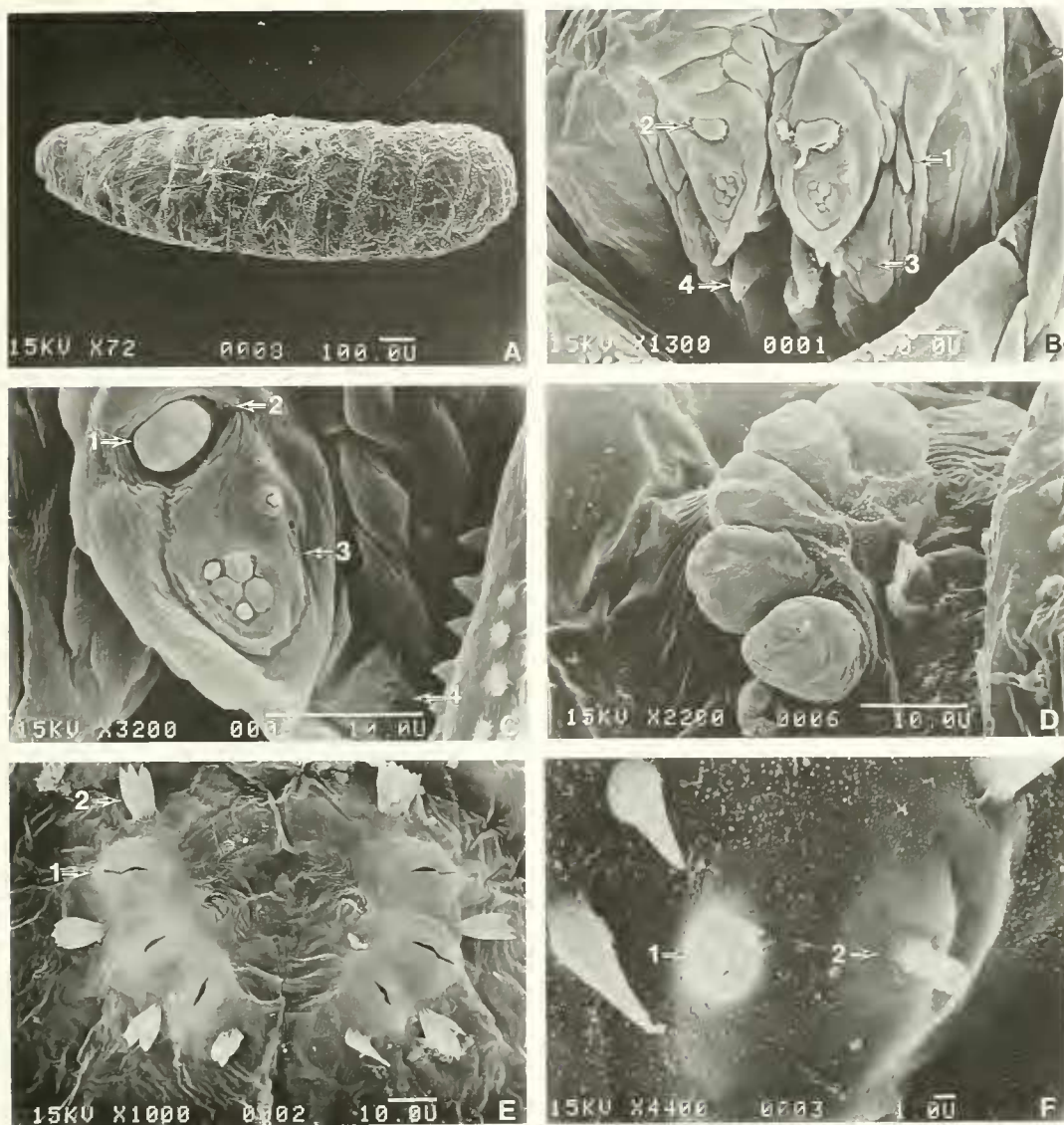


Fig. 3. Second instar of *Trupanea conjuncta*: (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal sensory organ, 3—stomal sense organ, 4—mouth hook; (C) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—subdorsal sensillum, 3—anterior sensory lobe, 4—stomal sense organ; (D) anterior thoracic spiracle; (E) caudal segment, 1—rima, 2—interspiracular process; (F) intermediate sensory complex, 1—medusoid sensillum, 2—stelex sensillum.

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1—minute acanthae, 2—rugose pads, 3—verruciform sensilla, 4—anterior thoracic spiracle; (F) fourth abdominal segment, 1—spiracle, 2—verruciform sensilla; (G) caudal segment, 1—minute acanthae, 2—stelex sensillum, 3—rima, 4—interspiracular process; (H) intermediate sensory complex, 1—medusoid sensillum, 2—stelex sensillum.

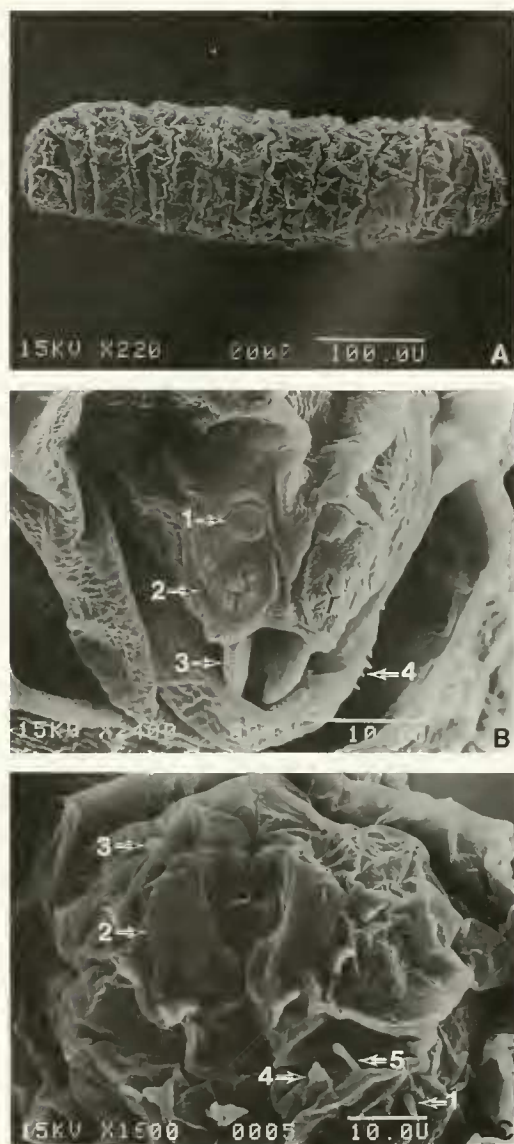


Fig. 4. First instar of *Trupanea conjuncta*: (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—anterior sensory lobe, 3—mouth hook, 4—minute acanthae; (C) caudal segment, 1—stelex sensillum, 2—rima, 3—interspiracular process, 4—intermediate sensory complex, medusoid sensillum, 5—intermediate sensory complex, stelex sensillum.

therein). The median oral lobe in *Aciurina trixa* Curran and *Paracantha gentilis* Hering is lobed along the ventral margin, but not laterally as in *T. conjuncta* (Headrick and Goeden 1990 Headrick et al. 1997).

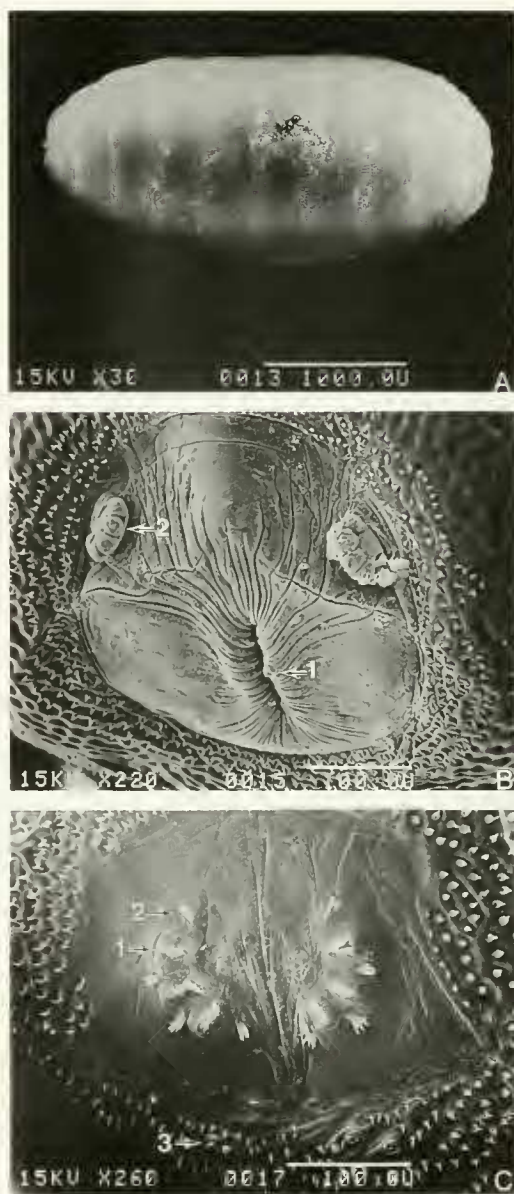


Fig. 5. Puparium of *Trupanea conjuncta*: (A) habitus, anterior end to left; (B) anterior end, 1—invagination scar, 2—anterior thoracic spiracle; (C) caudal end, 1—rima; 2—interspiracular process, 3—intermediate sensory complex.

The lateral spiracular complex of *T. conjuncta* is unique among *Trupanea* species previously studied in lacking verruciform sensilla on the metathorax (Knio et al. 1996). The lateral spiracular complex is the only morphological feature observed to dif-



fer among third instars of all seven species of *Trupanea* studied to date (Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997b, 1998; Goeden et al. 1998). Otherwise, *T. conjuncta* is similar to the other *Trupanea* species in general habitus and sensory structures; however, there are other slight similarities and differences between this and certain other *Trupanea* species. For example, the rugose pads on the gnathocephalon of *T. conjuncta* are not serrated, like those of *T. bisetosa* (Knio et al. 1996). A subdorsal sensillum is present, as noted with *T. bisetosa*, *T. jonesi* Curran and *T. pseudovicina* Hering (Knio et al. 1996, Goeden and Teerink 1998, Goeden et al. 1998), but not seen with *T. nigricornis* (Coquillett) or *T. signata* Foote (Knio et al. 1996, Goeden and Teerink 1997b). The anterior thoracic spiracle with five papillae has more papillae than all previously studied species, with the exception of *T. signata*, which has 4-5 papillae (Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997 b, 1998; Goeden et al. 1998). The interspiracular processes with 6-8 branches are similar to those reported for *T. bisetosa* and *T. californica* Malloch (Headrick and Goeden 1991, Knio et al. 1996).

The second instar differs from the third instar in general habitus, being more elongate-cylindrical than barrel-shaped, and in that the integument is smooth, not finely punctate. In contrast, the second instars of *V. californica* and *X. dichromata* were also shagreened like the third instar (Goeden et al. 1995, Goeden and Teerink 1997a). The second instar also lacks the rugose pads and verruciform sensilla which circumscribe the prothorax, and the mouth hooks are bidentate.

The first instar differs from the second instar in lacking rugose pads on the gnathocephalon and the stomal sense organ is indistinct. The greatest difference occurs in the spiracular system; the first instar typically lacks anterior thoracic spiracles and the posterior spiracular plate bears only two rimae. The interspiracular processes are not

greatly reduced as in *T. jonesi* (Goeden and Teerink 1998a).

The puparia of *T. conjuncta* are larger than those of *T. californica*, *T. imperfecta* (Coquillett), *T. jonesi*, *T. nigricornis*, and *T. pseudovicina* and smaller than those of *T. bisetosa* and *T. signata* (Goeden 1987, 1988; Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997b, 1998; Goeden et al. 1998).

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